- List the diagnostic features of jawless fishes, cartilaginous fishes and bony fishes.
- Describe the general characteristics of amphibians, reptiles, birds and mammals.
- Differentiate among monotremes, marsupials and placentals.
- Describe the evolutionary adaptations in concerned groups for gas exchange, transport and coordination.

Introduction

The kingdom Animalia includes all animals. The word animal is derived from Latin word **anima** which means breath or soul. Animals are multicellular ingestive heterotrophic organisms which are developed by fusion of haploid "n"non motile eggs and haploid "n" motile sperms. They were originated from animal-like protists. The branch of biology which deals with the study of animals is called Zoology.

9.1 Characteristics of Animals

All animals are eukaryotic multicellular heterotrophic organisms, found almost in all types of habitat (such as terrestrial, aquatic, aerial, arboreal etc). Most animals are **motile**, some are **sessile** but their larval stage is motile, few are parasite and size ranges from microscopic (worms) to very large in size (Blue whale) almost 150 tons. **Locomotion**, mostly by means of muscle fibers. Most animals contain two sets of chromosomes in their body cell. They **respire** both aerobically and anaerobically. The body of animals may be from soft to hard, diploblastic or triploblastic, either radially symmetrical or bilaterally symmetrical, few are asymmetrical. Their body is mostly covered with shell, chitin, bony plates, scales, furs, feathers etc. Bilateral symmetrical animals may be either **acoelomates** (Platyhelminthes) or **pseudocoelomates** (Nematodes) or **coelomates** (from Annelida to chordate). They possess only **ingestive heterotrophic** nutrition. Animals have either incomplete digestive system (single

opening) or complete **digestive system** i.e., tube like digestive system with mouth and anus at opposite ends. **Excretory system** is well developed in most animals while it is absent in poriferans and coelenterates. **Nervous system** in poriferans is absent while in coelenterates neuron net is present. It is well developed in most animals, sensory cells or sense organs are also present. **Respiratory system** is mostly present i.e., from arthropods to chordates, while lower non chordates respire only by diffusion from surrounding water.

Tit bits

Currently there are 66 thousand types of vertebrates, about 5% of total 1.3 million animal species.

Skeletal system is recorded in all animals, which is spicules or spongin fibers like in poriferans. In most invertebrates hydrostatic skeleton is present. While endoskeleton is recorded in few molluscs (cuttlefish), echinoderms and in all vertebrates. Exoskeleton is also present in many invertebrates (Arthropods, molluscs). It is also present in most chordates. The circulatory or **blood vascular system** is well developed from Annelida to Chordata, while in other invertebrates transportation occurs by diffusion.

All animals **reproduce** either asexually or sexually. Asexual by mitosis and sexual by meiosis and syngamy, embryo is present in all animals, they give birth to their young ones, or lay eggs.

Regeneration is present in poriferans, coelenterates, Platyhelminthes etc.

All animals lack cell wall, no plastids in their cells but **centrioles** are present.

9.2 Criteria for animal classification

Do you know?

The geometrical view of an organism is called symmetry. The asymmetrical animals do not exhibit symmetry.

Kingdom Animalia is divided into two subkingdoms i.e., parazoa and eumetazoa. (Table 9.1). The two subkingdoms are formed on the basis of presence or absence of cellular organization. The **parazoa** (para: beside: zoon; animal) are an ancestral sub kingdom of animals. They are simplest multicellular animals believed to be evolved from protozoans, their body is just collection of cells which are not differentiated into tissues or organs, there is some division of labour among cells but are not strongly associated to perform a specific collective function.

The only surviving parazoans are sponges belong to phylum **porifera.** Mostly asymmetrical animals, however, few are radially symmetrical.

Sub kingdom eumetazoa includes animals, in which body cells are arranged into tissues, the tissues organized into organs and organs into **organ systems** . The cells or tissues of eumetazoans are arranged into layers, either diploblastic (two germinal layers) or triploblastics (Three germinal layers). Germinal layers are present during development of an embryo.

Table 9.1 Broad classification of Kingdom Animalia based on common fundamental features

Kingdom	Levels of Organisation	Symmetry and Germinal Layers	Body Cavity or Coelom	Phylum
Animalia (Multicelluar)	Cellular Level (Parazoa)			Porifera
	Tissue / Organ / Organ System (Eumetazoa)	Radial (Diploblastic)		Coelentrata
		Bilateral (Triploblastic)	Without body Cavity	Platyhelminthes
			With false coelom (Pseudocoelomates)	Aschelminthes
			With true Coelom (Coelomates)	Annelids
				Arthropoda
				Mollusca
				Echinodrmata
				Hemichordata
				Chordata

Echinodermata exhibits radial or bilateral symmetry depending on the stage.

9.2.1 The sub kingdom eumetazoa can be classified on the basis of body symmetry into grade radiata and grade bilatera.

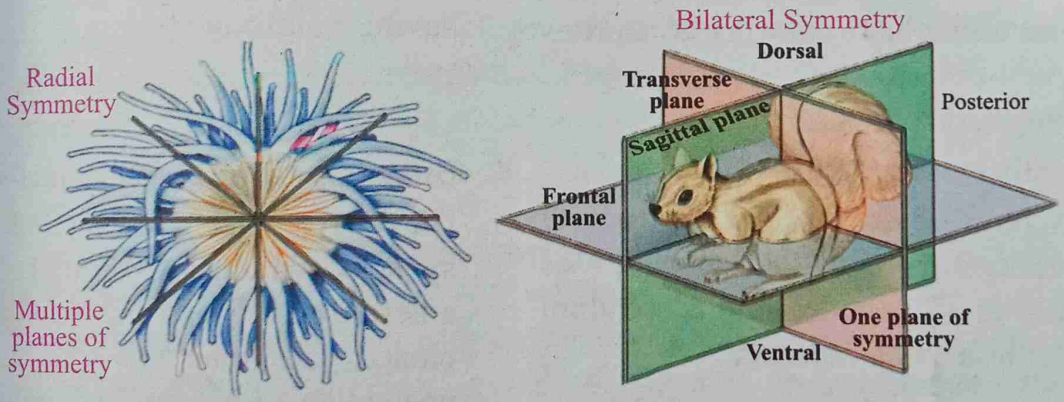

Fig. 9.1 Radial and bilateral symmetry

Table 9.2 Differences between Radiata and Bilatera

Grade Radiata	Grade Bilatera
1. This grade includes radially symmetrical animals e.g., coelenterates and adult of echinoderms.	1. This grade includes bilaterally symmetrical animals e.g., from phylum Platyhelminthes to Chordata.
2. The arrangement of body organ around a central axis and can be cut into two identical halves from any plane that pass through the central axis.	2. Their body can be cut into two identical halves from a single longitudinal plane running down the middle line.
3. No right and left side.	3. Right and left side, anterior and posterior ends, dorsal and ventral surface.
4. Mostly sessile animals thus considered an adaptation for a sessile life.	4. Mostly motile animals thus considered an adaptation to motility.

Table 9.3 Classification on the basis of arrangement of tissue layers, Either Diploblastic or Triploblastic

Diploblastic animals	Triploblastic animals
1. Two germ layers animals that is ectoderm and endoderm, in between these layers jelly like mesoglea is present which is mostly non cellular.	1. Three germ layers animals, the ectroderm, mesoderm and endoderm. These layers are visible only during embryonic development, later transformed into various organs.
2. Mostly devoid of specialized organs and organ systems.	2. Mostly specialized organs and organ systems are present.
3. They have no specialized nervous system rather have net work of neurons (nerve cells) with few ganglia. (aggregation of neurons).	3. They have specialized nervous system, having ganglia or brain.
4. Radially symmetrical animals.	4. Bilaterally symmetrical animals.
5. They have gastrovascular cavity with single opening, which act both as mouth and anus, example: phylum Coelenterata or Cnidarian.	5. They have well developed digestive system, which is tubular having anterior mouth and posterior anus or cloaca. Example: all phyla except coelenterata i.e. from Platyhelminthes to Chordata.

9.2.2 Classification of animals according to coelom (Body cavity).

Coelom is a fluid filled cavity between outer body wall and the alimentary canal which is lined by mesodermal membranes.

The grade Bilatera is divided into three groups on the basis of kind of coelom.

1. Acoelomate 2. Psuedocoelomate 3. Coelomate

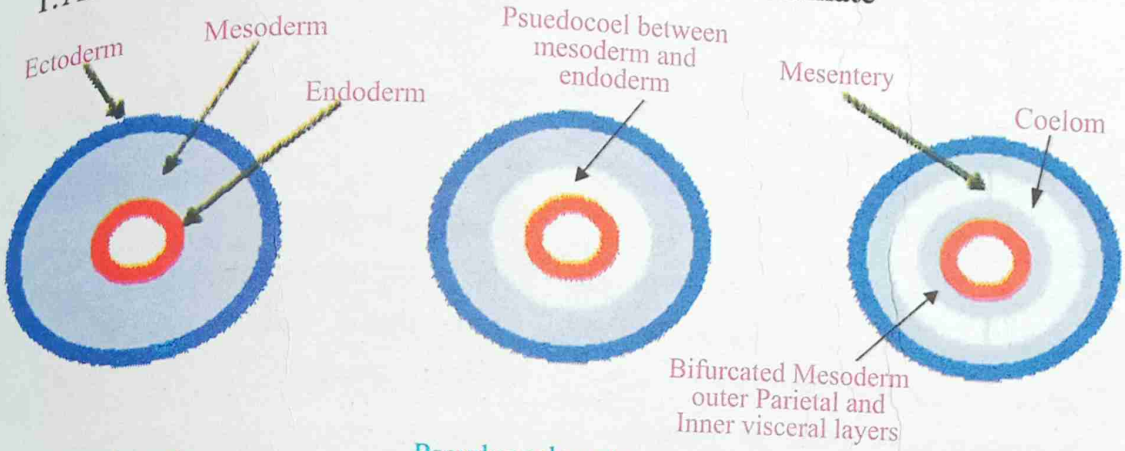

Fig. 9.2 Acoelomate Pseudocoelomate Coelomate

Table 9.4 Differences between Acoelomates, Psuedocoelomates and Coelomates

Acoelomates	Psuedocoelomates	Coelomates
1. No body cavity or coelom and recorded only in Platyhelminthes.	1. Possess false coelom thus called psuedocoelom and recorded only in nematodes (Aschelminthes).	1. Possess true body cavity or coelom and recorded from annelids to chordates.
2. No body cavity between digestive tract and outer body Wall, mesoderm form a loose, cellular tissue called parenchyma or mesenchyma.	2. Coelom is present between mesoderm and endoderm thus not covered by coelomic epithelium and is the remnant of blastocoel.	2. The mesoderm splits into outer parietal layer and inner visceral layer and filled with coelomic fluid.

9.2.3 Coelomates

Coelomates can be classified into two groups on the basis of early development.

1. Protostomes
2. Deuterostomes

The differences between Protostomes and deuterostomes are explained in table 9.5.

Tit bits

Cleavage is the division of zygote in which number of cells increase but size of cell hardly increase, cleavage is either radial or spiral.

Do you know?

*The **blastopore** is the first opening of the embryo while **archenteron** is the primitive gut.*

Critical Thinking

Bilateral symmetry is more successful body plane than radial symmetry. Can you guess why?

Table 9.5 Differences between Protostomes and Deuterostomes

Protostomes	Deuterostomes
1. Cleavage of zygote is spiral and determinate.	1. Cleavage of zygote is radial and indeterminate.
2. Blastopore or its anterior margin becomes mouth and anus is formed later on during development.	2. Blastopore become anus and mouth is formed afterwards during development.
3. **Schizocoelous** (that is coelom is formed by mesodermal splitting).	3. **Enterocoelous** (coelom is formed by out pouching of endoderm (archenteron).
4. The lips of blastopore produces mesoderm. **Examples:** Nematoda, Annelids, Molluscs and Arthropods.	4. The wall of archenteron produces mesoderm. **Examples:** Echinodermata, Hemichordata and chordata

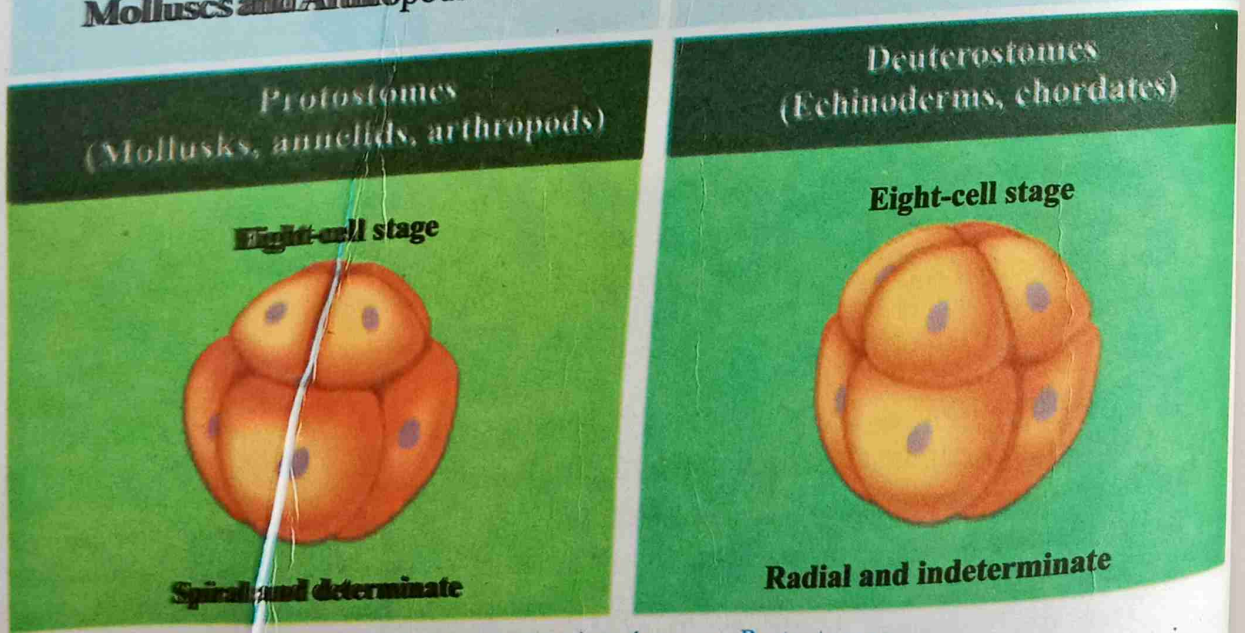

Fig. 9.3 Comparison between Protostomes and Deuterostomes

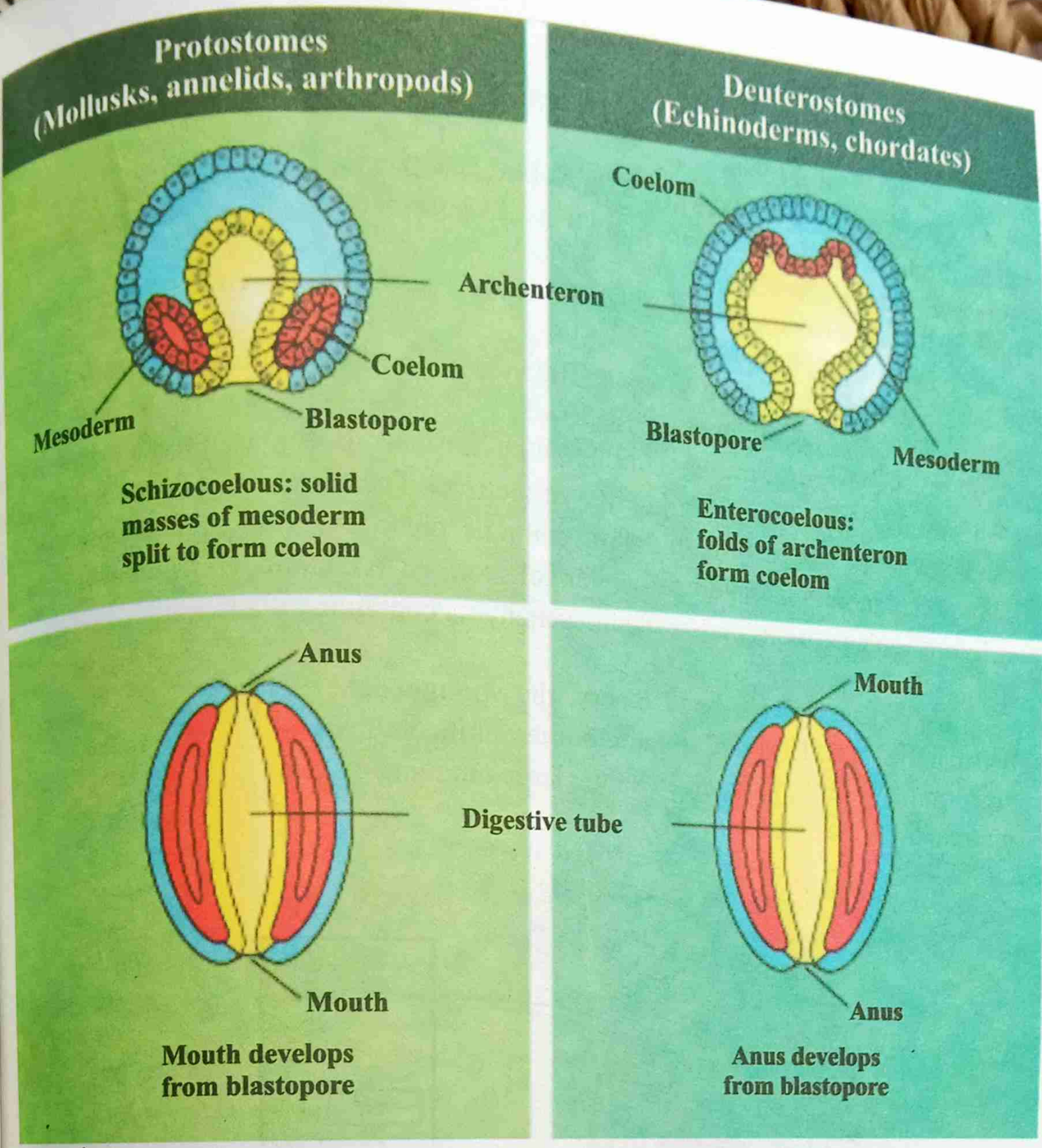

Fig. 9.3 Comparison between Protostomes and Deuterostomes